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EFFECTS OF SILVICULTURAL TREATMENTS ON OLD GROWTH CHARACTERISTICS AND ASSOCIATED WILDLIFE HABITAT

Preliminary Findings of the Lolo National Forest's 2006-2010 Old Growth Monitoring Study

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INTRODUCTION

This study (2006-2010) examines the effects that various vegetation management treatments and wildfires have on stand structure and the Lolo National Forest's ability to meet the Region 1 old growth definitions adopted by the Forest in 1994. It also examines whether old growth associated species continue to use treated stands after treatment and after wildfire. Three wildlife species which are commonly thought of as old growth forest associates are addressed in this report; the northern goshawk (*Accipiter gentilis*), the pileated woodpecker (*Dryocopus pileatus*), and the flammulated owl (*Otus flammeoulus*).

This study was designed to monitor old growth vegetation management treatments that were conducted across the Forest between 1995 and 2005. It examines four major questions:

> ***1) Do silvicultural treatments the Forest uses to restore or maintain old growth actually retain old growth characteristics sufficient to meet the Region 1 and Lolo National Forest Old Growth Definitions?***
>
> ***2) Do silvicultural treatments designed to restore or maintain old growth actually retain habitat suitable for old growth associated species?***
>
> ***3) Are stands treated to restore or maintain old growth used by old growth associated species?***
>
> ***4) Do stands treated to restore or maintain old growth differ from old growth stands affected by wildfires?***

Preliminary findings of this five year monitoring study provide additional information to the Forest about management of old growth and old growth habitat. As part of its adaptive management process, referred to as *"management control system"* within the Lolo National Forest Plan, the Forest will consider the findings of this study and adjust its old growth management activities accordingly (USDA 1986). Findings of this study will be updated and finalized in 2010, once all field surveys have been completed and analyzed.

Old Growth Management on the Lolo National Forest

The Forest's monitoring program has been, and continues to be, instrumental in promulgating changes to how old growth is managed.

In 1994, in response to its own monitoring findings and to agency direction to standardize old growth management, the Lolo shifted its treatment of old growth toward a more ecological approach. As part of its new management strategy, the Forest adopted old growth definitions that address forest types that commonly occur across the Region. ***Appendix 1*** provides an in depth look at the evolution of old growth management on the Lolo National Forest, including old growth definitions used by the Forest.

Since 1986, the Lolo has completed a variety of successful old growth enhancement projects. ***Appendix 2*** summarizes the results of the Forest's monitoring of these projects.

The Lolo has retained over 8% of its land base as old growth, thus meeting its 1986 Forest Plan allocation objectives. The Forest has also maintained old growth across a wide variety of habitat groups. ***Appendix 3*** discusses the Forest Inventory Assessment (FIA) data for the Lolo and examines current old growth quantity and distribution.

Today, at a very limited scale, the Forest continues to manage old growth to maintain viable populations of old growth associated species, as well as for other biological and social values. With an increasing emphasis on restoring the historical distribution and condition of old growth, the Forest continues to cautiously proceed forward with treating old growth stands in the warm-dry, low- to mid- elevation Habitat Groups where significant structural changes have occurred since European settlement (Losensky 1993, Agee 2003; Hessberg 2005).

Debate over Old Growth Management

As the Forest moves forward with vegetation restoration projects, there remains the question of whether active management should be used to maintain or restore old growth. Vigorous public and scientific debate have developed over the risks and trade-offs of forest restoration. With some, there is a desire to "let nature take its course" and to allow forests to recover and develop naturally (Agee 2002, Kimmins 2003). Others argue that treatments may be critical for restoring historical structures or processes (Fiedler 2007).

With this debate is the question of whether sufficient evidence is available to support that management actions can be used to restore old growth forest structure and habitat for old growth associated species.

In hearings concerning the Lolo National Forest's proposal to treat old growth under the Lolo's Post Burn Project, the 9th Circuit Court of Appeals found the agency's decision to be "arbitrary and capricious" because the Forest had not directly monitored the effects of its treatments on old growth associated wildlife species (*Ecology Center v. Austin*, *Ecology Ctr., 430 F.3d*, 2005). The Court said;

> ***"…the Forest Service's conclusion that treating old-growth forest is beneficial to dependent species is predicated on an unverified hypothesis. While the Service's predictions may be correct, the Service has not yet taken the time to test its theory with any "on the ground analysis," id., despite the fact that it has already treated old-growth forest elsewhere and therefore has had the opportunity to do so. …it is arbitrary and capricious for the Forest Service to irreversibly "treat" more and more old-growth forest without first determining that such treatment is safe and effective for dependent species."***

The judiciary acknowledged that silvicultural treatments *could* be beneficial for restorative purposes, noting that;

> ***"The Forest Service presents uncontested evidence that the failure to treat old-growth areas risks the vary harms feared by Ecology Center, even though it [Ecology Center] has provided no evidence to support such a claim. … In fact, the record reveals that the failure to treat old-growth areas could result in "considerable loss of old growth trees from bark beetle predation," which will put "at risk… specific habitat niches for many wildlife species that are adapted to the more open growth old-forest character." Old-growth areas "are now at risk for major disturbances such as disease and insect epidemics and high-severity stand replacing fires." Inaction or delay threatens the species Ecology Center seeks to protect."***

However, the court concluded that the Forest Service did "not offer proof that the proposed treatment benefits – or at least does not harm- old growth dependent species" (Ecology Ctr., 430 F.3d at 1063).

Subsequently, in a legal settlement for the Fishtrap, Mill-Key-Wey, and Knox-Brooks Projects on the Lolo National Forest, the agency agreed to "*monitor selected old growth stands which have been subject to old growth maintenance /restoration treatment projects, such as thinning or burning, to evaluate the affect of these Forest Service activities."* In part, the Fishtrap, Mill-Key-Way, and Knox-Brooks settlement was impetus for *this* monitoring study.

In 2007, the 9th Circuit Court of Appeals ruled in a separate decision on the Idaho Panhandle National Forest's *Mission Brush* project (*Lands Council v. McNair*, No. 07-35000 9th Cir. July 2, 2007). In this decision, the 9th Circuit Court stated that;

> ***"As in Ecology Center, the Forest Service is relying on the "unverified hypothesis" that "treating old-growth forest is beneficial to dependent species.".***

This decision has since been withdrawn. An en banc rehearing has been held and as of the date of this paper a new decision is pending.

Supporting scientific literature, findings from similar studies, and this study provide evidence concerning the effectiveness of old growth treatments and wildlife's use of treated areas on the Lolo National Forest. This study also provides verified observations of the effects of such treatments on old growth forests and associated wildlife species using a reliable and repeatable scientific methodology.

BASIS OF SCIENCE FOR OLD GROWTH TREATMENTS

Old Growth Vegetation Structure

A variety of scientific literature has been published that discusses the appropriateness of using silvicultural treatments to maintain or restore old growth vegetative structure (Habeck 1990, Losensky 1993, Arno 1997, Pfister *et al* 2000, Agee 2002, Allen *et al* 2002, Hessberg and Agee 2003, Sala and Callaway 2004, Hessberg *et al* 2005, Baker *et al* 2006, Abella *et al* 2007, Egan 2007, Fiedler *et al* 2007, Kaufmann *et al* 2007, Kolb *et al* 2007).

Appendix 4 examines recent scientific literature which discusses use of management treatments, (harvesting and prescribed burning) for restoring or maintaining old growth vegetation structure. ***Appendix 4*** also examines several already completed studies which conclude that such treatments are effective at maintaining or restoring desired old growth vegetative conditions in Forest types similar to those found on the Lolo National Forest.

Old Growth Associated Wildlife Habitat

Until now, the Forest has relied upon a variety of monitoring measures to predict the effects that its vegetation treatments may have on old growth associated wildlife. In addition to local sampling and regional population monitoring, the Forest has relied on a proxy, or "habitat association" approach, relating forest structural conditions to known habitat requirements to fulfill the question of whether old growth associates needs are met.

Appendix 4 examines the appropriateness of using "habitat associations." It also examines evidence that is available to support use of vegetative management to restore old growth species habitat. To ensure an understanding of the relationship of old growth associates and habitat, an overview of species habitat requirements is provided for the three species assessed within this study; northern goshawk, flammulated owl, and pileated woodpecker.

Restoration Defined

For the purpose of this study, the term "restoration" describes various treatments which mimic the dynamics of natural disturbance events. These treatments may be used to partially return, or improve existing conditions to those nearer the historic range of conditions at the stand or landscape level.

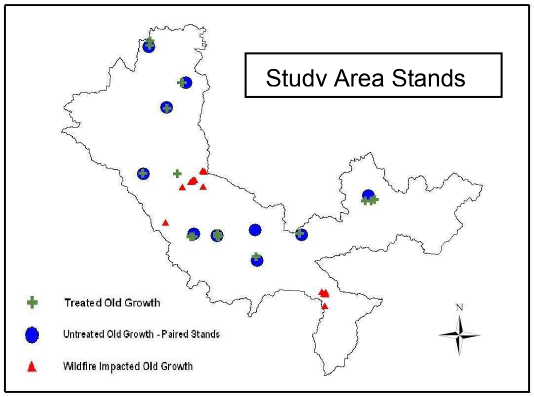
Restoration and maintenance treatments on the Lolo National Forest may include any one or combined actions of commercial harvesting, mechanical slashing or thinning of non-commercial trees, and prescribed burning. The need for restoration implies that managers have determined that a stand (habitat or landscape) is outside of some range of natural variability, or is at risk to biotic or abiotic factors which jeopardize its persistence on the landscape.

Restoration is the process of encouraging a system to maintain its function and organization without continued human intervention (National Research Council 1992). The degree to which the system can reach that desired range of behaviors will depend on many factors; cause and degree of degradation, irreversibility of past actions or changes, viability of remaining populations, financial resources, and the desired time frame for recovery (Moyle and Yoshiyama 1994).

Restoration should not be considered to be the return of a system to a fixed, pre-alteration condition (National Research Council 1995). Any restoration program should be nested within a larger program of landscape management that protects, retains, and restores ecosystem structure and function (Kohm and Franklin 1997).

STUDY AREA

For this study, a total of 37 different stands were examined. The study stands were located across the Lolo National Forest, and consisted of 17 treated, 9 untreated, and 11 burned stands.



In order to fulfill the study's purpose for assessing treatment effects on old growth, stands were only selected if they had pre-treatment inventory data showing they met the Forest's old growth criteria. In situations where the inventory data showed that the number of large, old trees was *"close"* to the old growth characterization, a field visit was completed to confirm that they fully met the criteria.

Each of the 17 treated study stands had received silvicultural and fuels management activities between 1995 and 2005. Treatments included: 1) ecosystem maintenance burning, 2) timber harvest, and 3) timber harvest followed by ecosystem maintenance burning. Based on a review of the original silvicultural prescriptions, the treatments prescribed for each stand were intended to improve old growth characteristics.

Nine untreated (control) stands were selected near the treated stands for wildlife monitoring and to compare vegetation and habitat characteristics. These stands have cover and habitat types similar to the treated or burned stands.

The 11 stands affected by wildfires consist of old growth stands that were burned at varying intensities (low, high, and mixed severity) by fires which had been ignited (natural or human caused) between 1995 and 2005.

The average size of the study stands is 44 acres. Their locations range in elevation from 3280 to 6720 feet above Mean Sea Level (MSL).

Managed (harvested or burned) old growth stands and paired untreated old growth stands are shown in Table 1. *All* of the managed old growth stands on the Lolo that met the above criteria were inventoried in this project with the exception of one research stand which was not evaluated in this study, yet is described in Appendix 4 (Sala and Callaway 2004).

Table 1 – Treated Stands

Stand	Treatment	Treatment Year	Paired Untreated Stand
32806003	Ecosystem Burn	2000	32805008
33202004	Improvement Cut	2000	33301017
40806058	Ecosystem Burn	1997	40806068 40806070
40806062	Ecosystem Burn	1997	
40806099	Ecosystem Burn	1997	
Includes old 40806090	Ecosystem Burn	1997	
42603046	Improvement Cut	2000	42604010
42704006	Individual Tree Selection Cut Ecosystem Burn	1997 1998	
50201040	Individual Tree Selection Improvement Cut Ecosystem Burn	1975 1996 1998	50205045
50205098	Improvement Cut	1997	50205045
51301040	Improvement Cut Underburn	1998-2002 2005	
51304036	Individual Tree Selection Underburn	2003 2005	51304019

Stand	Treatment	Treatment Year	Paired Untreated Stand
53302005	Improvement Cut Underburn	2004 2005	53302004
61201063	Improvement Cut	1996	61201094
61201078	Improvement Cut	2003	None
61204008	Improvement Cut Ecosystem Burn	1997 2001	None
74402084	Improvement Cut	2000	74402085
76901099	Individual Tree Selection	2002	None

Field surveys of stands burned by wildfire were conducted on three stands within the Siegel Creek Fire, and on seven stands within the Flat Creek Fire. Field surveys were also conducted on one stand located in the Cooney Ridge Fire.

Table 2 – Wildfire Burned Stands

Stand ID	Fire	Intensity	Acres	Field Survey Completed
38001031	Cooney Ridge – 2003	Mixed	42	Yes
52303023	Siegel Creek Fire - 2000	Low	46	Yes
52303026	Siegel Creek Fire - 2000	High	32	Yes
52303032	Siegel Creek Fire - 2000	High	59	Yes
76501071	Flat Creek Fire - 2000	High	17	Yes
76701010	Flat Creek Fire - 2000	Mixed	21	Yes
76701014	Flat Creek Fire - 2000	Low	47	Yes
76701015	Flat Creek Fire - 2000	Low	43	Yes
76701016	Flat Creek Fire - 2000	Low	9	Yes
76701019	Flat Creek Fire - 2000	Low	42	Yes
76802204	Flat Creek Fire - 2000	Low	11	Yes

METHODOLOGY

Vegetation Methodology

To identify the study's sample size, existing Forest stand-exam data was used to select old growth stands across the Forest and to confirm that each stand qualified as old-growth prior to treatment (Lolo National Forest TSMRS Database).

Once the old growth stands were identified, the ***treated*** and ***burned*** stands were field surveyed to assess post-treatment conditions. Forest Stand Exam Crews gathered vegetation information during the 2006 field season. Vegetation within each stand was measured using Northern Region Common Stand Exam (CSE) protocol (Common Stand Exam Field Guide for Region 1, Version 1.7, R1 Version 5.25.2006). Vegetation data was then aggregated to the stand level with the Region 1 Vegetation Classification Algorithms for Forested Vegetation (Berglund et al 2005). The CSE protocols were used to collect stand, plot, tree, surface cover, vegetation, and down woody material data. CSE provides one set of national data collection protocols, data codes, portable data recorder software, forms, reports, and export programs so data is reproducible and reportable. All stand examination data is stored in one common database structure; ***FSVeg***.

All live trees over 5 inches diameter at breast height (dbh) (4.5 feet above the ground) and dead trees between 5 and 8.9 inches dbh were sampled using a 20 Basal Area Factor (BAF) prism. Dead trees 9.0 inches dbh and larger were sampled using a 10 BAF prism to increase the sample size of these often relatively rare elements. Vegetation cover and ground cover data were taken on 1/300th acre plots. For down woody material, two fuel transects were taken at each plot, each with 7-foot transects for woody material less than 3 inches diameter and 50-foot transects for woody material over 3 inches diameter (Brown 1974). About 10 plots were taken per stand. This inventory was designed to achieve 20% standard error for basal area and large down woody material at the 95% confidence limit.

For the ***untreated*** old growth stands, a portion of the Common Stand Exam protocol was used to supplement information missing from the existing stand inventory data. Live tree, vegetation cover, and ground cover data were not sampled. Again, dead trees over 9.0 inches dbh were sampled using a 10 BAF prism to increase the sample size of these often relatively rare elements. Two fuel transects were taken at each plot, each with 7-foot transects for woody material less than 3 inches diameter and 50-foot transects for woody material over 3 inches diameter (Brown 1974). About 10 plots were taken per stand. This inventory was also designed to achieve 20% standard error for basal area of the snags and large down woody material at the 95% confidence limit.

Wildlife Methodology

In 2006 and 2007, 31 of the stands selected for vegetation monitoring were surveyed for the presence of northern goshawk and flammulated owl according to the methodology described for each species below.

Goshawk Survey Methods

Acoustical surveys for goshawks were completed in 2006 and 2007 and will continue through 2010 annually to acquire 5 consecutive years of monitoring information.

Goshawks surveys were conducted using the daytime acoustical broadcast calling method during the brood rearing period (nestling and fledgling stages). The field methods have been rigorously tested across known occupied goshawk territories in the south- and north-western United States and a national inventory protocol has been developed and tested in Regions 1 and 2 (Kennedy and Stahlecker 1993, Joy et al 1994, Watson et al 1999, Woodbridge and Hargis 2006, Kowalski 2006). The objective of this methodology is to provide complete survey coverage of the primary survey area (in this case the selected old growth stands) so that all portions of the survey area are within auditory detection distance (approximately 492 feet) of a call point (detection rate 0.69 to 1.0 for a two-visit protocol if a goshawk is present).

Experienced wildlife technicians broadcast recorded goshawk alarm calls from designated calling stations using a FoxPro calling unit. Broadcast calling stations were placed 984 feet apart on transects. Transects were separated by 820 feet, and broadcast calling stations on adjacent transects were staggered by 328 feet (to maximize coverage). All broadcast calling stations were mapped in GIS with the latitude and longitude of each station (or waypoint) downloaded onto a hand-held, Garmin E-Trex Global Positioning System (GPS) unit, so that surveyors could navigate to the calling points in the field, and each point could be revisited in subsequent years (see Appendix 8). Methods for downloading survey points to a GPS unit and navigation in the field to goshawk calling stations are described in Brewer et al. (2005).

All surveys were conducted during the brood rearing through young fledgling periods (June 26 through August 24), between sunrise and sunset. The brood rearing period is considered a time during which goshawks are nesting and rearing young chicks and thus their behaviors are centralized around the nest and vocalizations are common. At each calling station, surveyors broadcast the alarm for 10 seconds followed by a 30 second listening/watching period at 60 degrees, 180 degrees, and 300 degrees, for a total of four minutes per calling station.

Goshawk detections were characterized and recorded according to the methods described in Woodbridge and Hargis (2006). For example, when a vocal response or detection from a goshawk was elicited, the observer recorded the bearing and distance to the bird (at first detection), and these data were plotted on a map to better assess which stand or habitat type the bird was in originally. If a bird displayed aggressive or territorial behavior, a nest search was conducted in the vicinity.

Flammulated Owl Survey Methods

In 2006, flammulated owl surveys were conducted using nocturnal (night-time) acoustical calling methods at established calling stations according to the standardized protocol developed by the Avian Science Center, University of Montana (Cilimburg 2007). The flammulated owl was selected for monitoring because restoration treatments in old growth often target flammulated owl habitat, (dry ponderosa pine/Douglas-fir). Annual variation in breeding area occupancy by owls has not been identified as an issue like it has for the goshawk (Woodbridge and Hargis 2006). To conserve Forest resources, the Lolo National Forest determined monitoring for the owl could occur on alternate years (2006, 2008, 2010) to acquire 3 years of effective monitoring data over the 5-year period.

In cooperation with the Forest Service (Region 1), the Avian Science Center developed a survey protocol for detecting flammulated owls, as none previously existed (Cilimburg 2007). Flammulated owls are nocturnal feeders and "the" only migratory owl species in North America (they arrive in Montana from Central and South America in May). As such, traditional owl survey protocol methods (daylight hours from February to March) or other migratory bird surveys methods (daylight hours from April through July) won't work. Random flammulated owl surveys were conducted across all National Forests in Region 1, including the Lolo National Forest, to develop a survey protocol, determine the distribution of the owl in the Region, expand understanding of habitat associations, establish repeatable routes, and determine a detection probability.

For this study, 37 survey transects were established along existing roads located in or adjacent to the old growth stands selected for monitoring (see Appendix 8). The same broadcast survey points used for northern goshawks could not be used for flammulated owls. Due to obvious safety issues and the liability associated with nighttime surveys (i.e. documented nighttime encounters with black bears, potential for encounters with grizzly bears, mountain lions, and humans; or vehicle accidents due to low visibility) surveyors were required to work in pairs from a vehicle.

Acoustical calling stations were placed 1640 feet apart on transects. Similar to the goshawk protocol (described above), all calling stations were mapped in GIS and downloaded onto a GPS unit so that surveyors could navigate to the calling points in the field, and each station could be revisited in subsequent years. Experienced field technicians began broadcasting recorded male owl calls 15 minutes after sunset and continued until the calling points (8 to 20 per night) were completed. Flammulated owl calls were broadcast in all cardinal directions during a ten-minute calling/listening session from each calling station. If a response was heard, the observer recorded the compass bearing and estimated distance to the calling owl, then plotted the information on a map to determine the approximate habitat type and stand in which the owl was located. Actual area surveyed is based on the distance the observer could audibly detect owls. This is based on topography, ambient noise (streams, wind), and observer hearing acuity. Based on prior surveys, in quieter areas owls can usually be clearly heard more than 1,500 feet away and observers with excellent hearing and good noise conditions can hear owls more than 5,000 feet away. In Region 1, the estimated detection rate for owl surveys is 76% - thus, if an owl is present (within about 1,500 feet), there is a 76% chance of detecting it (Cilimburg 2006).

Pileated Woodpecker Survey Methods

The timing of acoustical broadcast calling methods for pileated woodpeckers (including daytime hours during the breeding season), directly overlaps with the timing of goshawk surveys. The two species cannot be surveyed using the acoustical calling method in conjunction with each other because pileated woodpeckers are goshawk prey. Pileated woodpeckers are the only large woodpecker inhabiting the Lolo National Forest that excavate and utilize large, conspicuous cavities. As such, the abundance of large nest cavities and smaller foraging holes in a stand can provide an index to the concentration of use by pileated woodpeckers. During the non-breeding season when birds are less conspicuous, wildlife tree and indirect sign surveys for woodpecker feeding, roosting and nesting excavations are recommended as indicators of woodpecker presence (Inventory Methods for Woodpeckers, Standards for Components of British Columbia's Biodiversity No. 19. Ministry of Environment Lands, and Parks for the Terrestrial Ecosystem Task Force Resources Inventory Committee, September 14, 1999 Version 2.0). Similar methods have been used to effectively identify presence, or absence of pileated woodpecker in other studies (Hutto and Young 1999, 2000; Young and Hutto 2002, Bull *et al* 2005).

In 2006, presence of pileated woodpeckers was assessed as the proportion of the number of dead trees measured in each stand (described in the vegetation section) that contained large cavities

(> 3” diameter) within each of 31 stands. In addition, direct observations of woodpeckers (unique drum or call heard, or individuals sighted) were also recorded by field observers during the time dead tree measurements were being taken (Hutto and Young 2000). Hutto and Young (1999, 2000) and Young and Hutto (2002) describe the methodology used in Region 1 to assess pileated woodpecker (and other bird species) presence by recording direct observations (unique drum or call heard, or individuals sited) in stands while walking to, between, or at land bird listening stations. The same methods were used in this project while field technicians were measuring the number of dead trees with large cavities at and between stand exam plots in each stand, as well as at and between goshawk calling points in 2006 and 2007. Direct observations will be recorded in the same manner annually through 2010.

Calculating Detection Rate and Stand Use

An overall detection rate for goshawks was calculated as the total number of vocal responses heard plus the total number of silent approaches observed divided by the total number of broadcast calling stations. Goshawk use was determined by dividing the total number of stands that had detections by the total number of stands surveyed in each of three categories (treated, untreated, and burned).

A detection rate for flammulated owls was calculated as the total number of vocal responses heard divided by the total number of broadcast acoustical calling stations. Use was determined as described for goshawks above.

An index of use by pileated woodpeckers was determined by first dividing the total number of dead trees with 3” cavities by the total number of dead trees measured in each stand to obtain a proportion of use (between 0 and 1) per stand. Overall use was determined by simply calculating the mean for treated, untreated, and burned stands.

Habitat Component Assessment

To assess whether treatments designed to improve old growth created or maintained stands suitable for old growth associated species, vegetative attributes measured in each of the 16 treated stands, pre- and post-treatment and in the 9 untreated (control) stands were compared to the same vegetative attributes (or key habitat components) measured at known sites in Region 1 for northern goshawk, flammulated owl, and pileated woodpecker (summarized in Samson 2006a). Results were tallied and displayed in table format (Appendix 9, Tables 2, 3, 4). Similar survey methods described were applied to all stands affected by wildfire.

STUDY RESULTS – VEGETATION

Treated Stands

15 of the 17 (88%) old growth stands that were assessed for the effects of management treatments including ecosystem maintenance burning, timber harvest, and timber harvest followed by burning, continued to meet the old growth definition after treatment. Two stands (42704006 and 51304036) did not meet old growth criteria after treatment. In the first instance, old growth characteristics were lost because of tree mortality following “too hot” of a prescribed burn following harvest activities. In the second instance, it was discovered during the course of this study that, while the remainder of the untreated stand met old growth criteria before and after treatment, the portion of the stand that was treated did not actually meet the old growth criteria prior to, or following treatment. The stand was retained in the study despite this finding to assess whether the overall restoration treatment objectives were met. In the treated portion of this stand, they were not met.

Table 3 –Old Growth Retention in Treated Stands

Activity	Number of Old Growth Stands Sampled	Number of Stands That Meet Green et al Old Growth	Percent of Stands That Remain Old Growth
Ecosystem Maintenance Burning	4	4	100%
Timber Harvest (variations	7	7	100%

of thinning from below)			
Timber Harvest Followed by Burning	6	4	67%
Management Total	**17**	**15**	**88%**
Wildfire – Low Intensity	6	1	17%
Wildfire – Mixed Intensity	2	0	0%
Wildfire – High Intensity	3	0	0%
Wildfire Total	**11**	**1**	**9%**

Stands with Ecosystem Maintenance Burning

All four of the stands receiving ecosystem maintenance burning treatments (without harvest) retained their old growth characteristics following treatment. Old growth characteristics of these stands are displayed in Appendix 5.

One of the four stands (32806003) evaluated after treatment, lost a portion of its large live tree component in a portion of the stand. In this portion of the stand, a mean of six trees per acre over 21 inches diameter at breast height (dbh) with a standard error of two trees per acre was measured rather than the mean of eight trees per acre required by Green et al (2005). This stand would have met the minimum large tree requirement over its entire area if the southwest corner had not burned so hot. Plot 4, located in that area, had ten dead trees of which three were over 21 inches dbh. That plot brought the average number of large trees per acre down. Although treatment of this stand resulted in the creation of a small area that no longer meets the old growth criteria because of the unintentional effects of a prescribed fire, this variability is consistent with the old growth definition and with historic ecological processes on this type of site (Fischer and Bradley 1987). Therefore, overall, the stand, still meets the old growth definition.

Stands with Timber Harvest

All but two (85%) of the thirteen stands that received timber harvest activities met the old growth criteria after harvest.

Eight of these stands met all old growth criteria without the need for additional field assessments to confirm information from the 2006 surveys. These stands included 50201040, 50205098, 51301040, 61201063, 61201078, 61204008, 74402084, and 76901099. Five stands including 33202004, 42603046, 5330200, 542704006, and 51304036 showed fewer large trees per acre than the minimum criteria and required subsequent field verification and analysis (beyond the collected stand exam plot data) as recommended by Green et al (2005). That evaluation resulted in the determination that three of these stands still met the old growth definitions (stands 33202004, 42603046, 5330200). Two stands, 42704006 and 51304036, did not meet the old growth criteria after treatment and evaluation.

Stand 42704006 was burned too intensively. In the second instance, the treated portion of stand 51304036 did not meet the old growth definition prior to, or following harvest. In this situation, while old growth characteristics were retained at the overall stand level, the management activities conducted in the portion of the stand that was treated did not achieve the silvicultural objectives to maintain or restore old growth characteristics.

Stand 33202004 is the redelineated (harvested) part of four parent stands. Each of the four parent stands had exams showing the stands were very close to meeting the old growth minimum criteria for eight large trees per acre. The statistics for each stand showed means of seven large trees per acre with standard errors of two to four trees per acre. These stands were determined to be old growth based on the observation that some trees from the next smaller diameter class, 19 to 20.9 inches dbh, have grown into the 21+ inch diameter class during the 20 years since the exams were done. Large tree distribution is somewhat patchy throughout the area. The silviculturist who evaluated the area prior to harvest noted *"understory reinitiation stage moving toward theoretical climax/old growth where all seral species have fallen from the stand."* The harvest was an improvement cut in 2000 that reserved large trees from harvest. The post-harvest monitoring exam showed a mean of six large trees per acre with a standard error of three trees per acre. Field surveys determined that the area still met the old growth criteria.

Stand 42603046 had two exams completed prior to treatment. The two exams showed a wide difference in the number of large trees per acre.

One showed 9 trees large trees per acre and the other showed 15 large trees per acre. This illustrates the patchy distribution of large trees within the stand and the variation that can occur with different sampling designs when looking for relatively rare elements (large trees). Prior to treatment, the stand was field checked to confirm that it met the old growth definition. The harvest was an improvement cut in 2000 that reserved large trees from harvest. The post-harvest monitoring exam showed a mean of five large trees per acre with a standard error of two trees per acre. The stand was revisited and it was determined that it still met the Green *et al* (2005) descriptions of Type 1 old growth because the large trees were still there and the stand structure was consistent with the old growth description.

Stand 42704006 is the re-delineated (harvested) part of three parent stands. Each of the three parent stands had exams showing they met the old growth minimum criteria for eight large trees per acre. The statistics for each stand showed means of 10 to 16 large trees per acre. Prior to treatment, the stands were field checked and it was determined that they met the old growth definition. This stand was monitored by researchers with the Rocky Mountain Research Station as an experiment in old forest restoration (Arno *et al* 1995, Arno *et al* 1997, Hillis *et al* 1999). The harvest was an individual tree selection cut in 1997 that reserved large trees from harvest. Post-harvest monitoring as documented in Hillis *et al* (1999) showed the harvest activity was successful at restoring historical old forest structure and composition. However, the stand was burned with deviation from the prescribed burn plan, which resulted in excessive mortality on 15 acres with heavy crown scorching over about 30 acres. A reforestation exam in October 2003 found live old growth trees on 8 out of 34 plots (1/50th acre plots) averaging 16 old growth trees per acre. The 2006 post-harvest monitoring exam showed subsequent delayed mortality which left a mean of one large tree per acre with a standard error of one tree per acre. The area, therefore, no longer meets the old growth definition.

Stand 51304036 had an exam completed prior to harvest that showed a mean of nine large trees per acre. Prior to treatment, this stand was field checked and it was determined that it met the old growth definition. Within the stand, the majority of large trees were located above the road where timber harvest was not planned, but they were also well distributed at lesser levels below the road where timber harvest was planned. The harvest occurred only on the part of the stand below the road. Because the treatment was an improvement cut, it reserved the large trees from harvest. The post-harvest monitoring exam on the treated part of the stand showed a mean of five large trees per acre with a standard error of two trees per acre. An additional visit was performed and it was determined the stand as a whole, including both areas above and below the road, still met the Green et al (2005) descriptions of Type 1 old growth because the number of large trees did not change and the old growth structure was retained. However, because the harvested portion by itself did not meet the old growth criteria following harvest, the objective to maintain or restore old growth was not met.

Stand 53302005 had an exam prior to harvest that showed a mean of ten large trees per acre. Prior to treatment, the stand was field checked and it was determined that it met the old growth definition. Because the harvest that was conducted in 2004 was an improvement cut, it reserved the large trees from harvest. The post-harvest monitoring exam showed a mean of five large trees per acre with a standard error of one tree per acre. Because large trees were reserved from harvest, a silviculturist compared the exam designs of the two inventories. The stand is on a hillside with very broken topography. It was striking that the original exam had most of the plots on or near ridgetops while the monitoring exam had a distribution that leaned more towards locations in the swales between the draws. The stand was re-visited and it was determined that as a whole it still met the Green et al (2005) descriptions of Type 1 old growth because the number of large trees did not change and the stand structure met the old growth definition.

Stands Affected by Wildfire

Only 1 of the 11 (9%) study stands retained its values as live old growth forest habitat after being burned by wildfire.

With two exceptions, none of the old growth stands burned in wildfires had any history of management activities. Under both exceptions, in 1995, an area consisting of approximately 2 acres of the 43 acre stand in 76701015, and 4 of the 9 acres in 76701016, had wind damaged trees salvaged along a Forest road which passed through the two stands. Only down trees were salvaged, no standing trees were cut in these previous treatments.

Three of the stands affected by wildfire were identified as having high intensity fires (stand-replacing), two of the stands were identified as having mixed intensity fires (patchy stand-replacement), and six of the study stands were identified as having low intensity fires (underburns). 100 percent of the stands that burned with high intensity lost their old growth characteristics, 100 percent of the stands that burned with mixed intensity lost their old growth characteristics, and 83 percent of the stands that burned with low intensity lost their old growth characteristics.

Ninety-one percent of the old growth stands burned by wildfires lost their old growth characteristics through a combination of direct fire mortality, delayed fire mortality, and mortality caused by post-fire agents such as bark beetles.

Stands with High Intensity Wildfire

Of the three stands identified as having high intensity wildfire (52303026, 52303032, 76501071), none retained their old growth characteristics. Stand examinations showed virtually no live trees over 5 inches dbh left in these areas.

Stands with Mixed Intensity Wildfire

Two stands were identified as having mixed intensity wildfire.

Stand 38001031 burned with mixed intensity in the Cooney Ridge fire in 2003. A comparison of the stand examination data collected before the fire to that collected after the fire showed a reduction from 11 to 6 large live trees per acre, a reduction from 147 square feet of basal area per acre to 86, and an increase from 8 snags per acre over 9 inches dbh to 27. After burning, this stand no longer met the Green et al (2005) old growth definitions based on the shortage of large live trees.

Stand 76701010 burned with mixed intensity in the Flat Creek fire in 2000. A comparison of stand examination data collected before the fire to that collected after the fire showed a reduction from 12 to 0 large live trees per acre, a reduction from 80 square feet of basal area per acre to 6, and an increase from 22 snags per acre over 9 inches dbh to 81. After the wildfire, this stand no longer met the Green et al (2005) old growth definitions.

Stands with Low Intensity Wildfire

Six stands were identified as having low intensity wildfire.

Stand 52303023 burned with low intensity in the Siegel Fire in 2000. A comparison of the stand examination data collected before the fire to that collected after the fire showed a reduction from 22 to 9 large live trees per acre, a reduction from 113 square feet of basal area per acre to 52, and an increase from 5 to 24 snags per acre over 9 inches dbh. This stand still qualified as old growth after burning.

Stand 76701014 burned with low intensity in the Flat Creek fire in 2000. This stand was identified as high risk for Douglas-fir beetle, and it was examined in 2001. A comparison of the stand examination data collected in 2001 to that subsequently collected in 2006 showed a reduction from 67 to 1 large live trees per acre and a reduction from 240 square feet of basal area per acre to 2. This stand is a classic example of delayed fire mortality, primarily in the smaller trees, compounded by a Douglas-fir beetle outbreak in the large trees. The mortality in this stand is scattered throughout the stand in pockets of varying sizes and scattered individual trees. Oblique observations of this stand indicated that only one-quarter to one-third of the canopy coverage was in live trees. A follow up walkthrough of the stand in December, 2006, verified that virtually all of the large old Douglas-fir trees were dead from bark beetles. This stand no longer met the old growth definitions after burning.

Stand 76701015 burned with low intensity in the Flat Creek fire in 2000. This stand was identified as high risk for Douglas-fir beetle, and it was examined in 2001. A comparison of the stand examination data collected before the fire to that collected immediately after the fire, and then again in 2006, showed a reduction from 17 to 10 to 4 large live trees per acre respectively, a reduction from 131 square feet of basal area per acre to 100 to 70, and an increase in snags over 9 inches dbh from 1 to 30 trees per acre. This stand is an example of a lodgepole pine/Douglas-fir stand where the lodgepole pine died during or within a year after the fire followed by a Douglas-fir beetle outbreak in subsequent years in the large. This stand no longer met the Green et al (2005) old growth descriptions.

Stand 76701016 burned with low intensity in the Flat Creek fire in 2000. A comparison of the stand examination data collected in 1976 to the 2006 exam show a reduction from 5 to 3 large live trees per acre, a reduction of 167 square feet of basal area per acre to 50, and an increase in snags over 9 inches dbh from 17 to 46 trees per acre. This stand no longer met the old growth definition.

Stand 76701019 burned with low to mixed intensity in the Flat Creek fire in 2000. This stand was identified as high risk for Douglas-fir beetle, and it was examined in 2001. A comparison of the stand examination data collected after the fire to that collected in 2006 showed a reduction from 13 to 3 large live trees per acre and a reduction from 104 square feet of basal area per acre to 80. Based on recent aerial imagery and field surveys it did not meet the Green et al (2005) old growth descriptions.

Stand 76802204 burned with low intensity in the Flat Creek fire in 2000. A comparison of stand examination data collected in 1995 to the 2006 data showed a reduction from 8 to 3 large live trees per acre and reduction from 136 square feet of basal area per acre to 50. This stand did not meet the Green et al (2005) old growth definitions based on insufficient basal area and large live trees.

STUDY RESULTS - WILDLIFE

Wildlife detection surveys completed in 2006 and 2007 documented all three monitored species in or near treated and untreated stands. With the exception of northern goshawk, monitored species were also detected in burned stands. Occupancy of pre-treatment/pre-burn stands was not documented for goshawks, flammulated owls, or pileated woodpeckers. As such, effects of treatment and wildfire on breeding individuals could not be assessed (see below). Of note, the final sample size differs slightly from the vegetation effects section above. One stand included in the vegetation section was dropped from the wildlife analysis because the stand was added late in the first season and could not be sampled for species presence. The final list of stands sampled for wildlife is displayed in Appendix 9, Table 5.

Table 4 – WILDLIFE DETECTION RESULTS

	Goshawk Detections			Flammulated Owl Detections	Pileated Woodpecker Cavities
	2006	2007	Total (%)	2006	2006
Treated	2/16	2/16	4/16 (25%)*	1/16 (6%)	7/16 (44%)
Untreated	0/9	1/9	1/9 (11%)**	1/9 (11%)	5/8 (63%)
Burn	0/6	0/6	0/6 (0%)	1/6 (17%)	2/6 (33%)
Total	2/31	3/31	5/31 (16%)	4/31 (10%)	14/30 (47%)

* Responses include 2 vocal approaches (stand numbers 50205098 and 40806058) and 2 silent approaches (stand numbers 42603046 and 76901099) by 4 separate adult birds.

**Response includes 1 vocal approach by a pair of adult goshawks in stand number 51304038.

Goshawk Surveys

A total of 208 broadcast calling stations were completed (104 in 2006, 104 in 2007) with 5 goshawks responding to broadcast alarm calls (2 in 2006, and 3 in 2007) for an overall detection rate of 2.4% (5 responses per 208 calling stations). Responses included: 3 vocal approaches from adult goshawks (presumed females) and 2 silent approaches (1 male, 1 sex unknown). A vocal approach by an adult in response to a broadcast alarm call indicates an active nest is within 656 feet (Joy et al. 1994; Woodbridge and Hargis 2006). A silent approach from an adult female also means a nest is within 656 feet; however, adult males, will frequently fly silently in the direction of the surveyor to investigate, and such responses may be long distances from the nest, but within the foraging territory (Joy et al. 1994; Woodbridge and Hargis 2006).

As Table 4 displays, four (2 vocal approaches, 2 silent approaches) of the five total goshawk detections were elicited from broadcast calling stations located inside four separate stands that had been treated with improvement cuts and/or ecosystem burns to improve old growth characteristics, and one detection was elicited from an untreated stand. Intensive nest searches in the sample stands did not result in the finding of a nest location. Searches were also conducted in neighboring stands, none of which resulted in finding a nest location. The response types (vocal or silent approach), compass bearings and estimated distances to the responding hawks indicate that goshawks were likely nesting in close proximity to 11% (1 of 9) of the untreated stands sampled and 0% (0 of 6) of the burned stands sampled. Of the treated stands sampled, 25% (4 of 16) were likely inside a goshawk territory with half of those (2 of 16) likely in close proximity to a nest and the other half (2 of 16) unknown.

Surveys will continue for goshawks in 2008, 2009, and 2010.

Flammulated Owl Surveys

In 2006, flammulated owls_were detected at 4 of 160 broadcast calling stations distributed in and around 31 old growth stands. The detections represent 3 individual responses. The compass bearings and estimated distance recorded to the responding birds indicated that one responding owl was located inside a stand (50205098) treated with an improvement cut in 1997. The remaining two detections were located, one each, in the vicinity (but not inside the stand boundaries) of an untreated stand (40106008) and a stand that burned with mixed severity in 2008 (38001031) (see Appendix 8). No pre-treatment/pre-burn survey data for owls are available for comparison. Owls were not surveyed for in 2007, but will be surveyed for in 2008 and again in 2010.

Pileated Woodpecker Surveys

Data on the presence of large cavities (> 3 inches in diameter) in dead trees were assessed from the stand data collected in 2006.

Table 4 shows that pileated woodpecker use of untreated (control), treated, and burned areas is relatively common with the highest number of stands with large cavities occurring, in ascending order, in untreated stands (63% of the stands sampled), treated (44%), and wildfire (33%).

A detailed assessment of the stand data for each stand, showed that in untreated (control) stands an average of 10% of the snags measured had nest cavities, and in treated stands an average of 9% of snags measured contained nest cavities. In burned stands, although there were high densities of snags, only 1% of suitable snags measured contained nest cavities.

Habitat Components and Species Presence

Appendix 9, Tables 2, 3, and 4 summarize results from assessing the total number of untreated, treated (pre- and post-) and burned (pre- and post-) stands that provide a range of habitat conditions consistent with where the species actually occur in this part of their range.

The low number of available sample stands and the fact that each species resides in a broad range of habitat conditions not defined by Green et al., alone, resulted in the Forest monitoring for species presence only in treated and burned stands with pre-treatment/pre-burn data. Therefore conclusions are not based on statistical power, rather they are based on the actual total and average conditions observed. Nonetheless, some obvious conclusions can be drawn from monitoring.

For goshawks, old growth treatments on the Forest generally occur in goshawk foraging habitat and outside of goshawk nesting habitat. Only 1 of 16 treated stands appeared suitable for goshawk nesting prior to treatment (420603046). In this stand, post-treatment canopy cover and basal area were below densities where goshawks typically nest. The remaining 15 treated stands sampled were located on drier, south slopes, where goshawks are rarely found nesting because these sites do not typically contain forest structural components (higher canopy cover and basal area) needed by goshawks. (Appendix 9, Table 2, Row C). For goshawk foraging, 13 of the 16 treated stands sampled had canopy cover > 40% pre-treatment. Post treatment, only 1 of the 13 foraging stands had > 40% canopy cover. Goshawk foraging areas are heterogeneous and may include mature forest (> 40% canopy cover), as well as a mix of other forest (< 40% canopy cover) and non-forest components (i.e., sagebrush, grasslands, lowland riparian, and agriculture) (Reynolds et al. 1992; Reynolds 1994; Young and Bechard 1994; Patla et al. 1997, McGrath et al. 2003).

Given the detection data, goshawks are clearly present in areas that contain managed old growth stands, however, the degree to which goshawks are using the managed stands for foraging cannot be assessed through standard goshawk inventory methods. Although 15 of 16 stands sampled for goshawk suitability met the minimum criteria for old growth, post-treatment overstory tree densities (measured by canopy cover) remain below the 40% generally used to characterize and quantify one of the forested components that make up goshawk foraging habitat (Appendix 9, Table 2). All treatment types (ecosystem maintenance burn, harvest, or harvest and burn) appeared to contribute evenly to the change in canopy, although goshawks were detected in association with all treatment types.

For flammulated owl (Appendix 9, Table 3), results show that old growth treatments often target flammulated owl habitat (10 of 16 stands). All treatment types reduced canopy cover below the 35 to 85% range (0 of 16 stands had canopy cover above 35%), while maintaining other structural components such as large trees and snags. Of note, 13 of 16 stands (81%) had post treatment canopy cover (>20%) consistent with where owls have been previously detected on the Lolo National Forest (unpublished data). The one owl detection in a treated stand (50205098) occurred in habitat that is inconsistent with where the owl typically occurs (i.e. the stand was on a north slope, with higher densities of smaller diameter trees).

For pileated woodpecker (Appendix 9, Table 4) all treated stands (16 of 16) provided habitat consistent with where the species typically occurs, and this is corroborated by the presence of large cavities at frequencies similar to the control stands (discussed above).

Habitat and Occupancy of Wildfire Stands

Thus far, the only apparent difference among old growth associates are that goshawks have not been detected in areas burned by wildfire; with the majority of the detections (4 of 5) occurring in treated areas. In contrast, flammulated owl and pileated woodpecker were detected in burned and treated areas (Appendix 9, Table 4).

For all three species that nest or forage in forests with some live canopy, fires removed all or a portion of the live component, whereas, treated areas maintained more of the structural components typical of where each species occurs (Appendix 9, Tables 2 through 4).

CONCLUSIONS AND DISCUSSION

Vegetation

Monitoring of old growth stands treated over the past ten years through timber harvest or timber harvest followed by burning shows the Lolo has been able to successfully maintain or restore 88 percent (15 out of 17) of the old growth stands it treated by retaining the vegetative characteristics of old growth as described in Green et al (2005).

In the one stand where old growth characteristics were lost due to management activities (42704006), the burning activity was the trigger for losing those characteristics. The stand was independently verified by researchers from the Rocky Mountain Research Station as being restored to historic old growth conditions after the harvest, but the burning activity unfortunately caused both direct and delayed mortality of large trees in parts of the stand (Hillis et al, 1999). The excessive overstory mortality that resulted from prescribed fire emphasizes the challenge that managers face in reintroducing fire to old-forest ponderosa pine communities. Although some mortality of old-forest trees is inevitable as fire is reintroduced throughout western forests, managers must continually apply adaptive management to avoid undesirable mortality. In this particular case, the goal for reducing operational expenses led to the use of a higher risk helicopter ignition method. However, it was the rate of ignition, not the ignition tool, which caused the high mortality burn. Ignition rate – how quickly a burn is ignited, how much fire is lit with each ignition strip (e.g. drops of fuel or splashes of fuel), and how far apart the ignition strips are – affect fire behavior.

The harvested portion of one stand (51304036) did not meet old growth definitions after harvest because although the stand as a whole met the definitions, that portion of the stand that was treated did not quite meet old growth definitions by itself prior to harvest. Old stand examination data and silviculturist observations suggest the concentration of large trees above the road and outside the harvested area led to the identification of the stand as meeting old growth. The large, old trees were retained in the unit.

One prominent treated old growth stand was not included in this study but is discussed in Appendix 4. Stand 33202006, an old growth stand near Snowbowl, has been the object of ongoing research on the effects of management treatments on old growth (Sala and Calloway, 2004, Sala *et al* 2005). This stand and the research results were featured in an article in the *Missoulian* on October 29, 2006. Ongoing monitoring by the researchers has shown various burning and thinning treatments can be used to restore physiological processes promoting longevity, insect and disease resistance, and fire tolerance within old trees while maintaining characteristics associated with old growth.

Research in other places confirms the findings of this monitoring study. For example, Quesnel and Seeger (2002) found that timber harvest designed to restore or maintain old growth was successful at maintaining both vegetative and habitat characteristics associated with old growth. Hawe and Delong (1997) found that timber harvest followed by burning to restore or recruit old growth is feasible in southern British Columbia. Habeck (1990) reported that mechanical treatments and prescribed fire are necessary to decrease wildfire potential and preserve pine/larch old growth forests in western Montana.

Management activities were considerably more successful at maintaining old growth stand characteristics than wildfires. Wildfires maintained old growth characteristics in only 9 percent (1 out of 11) of the stands. As with the management burning activities, direct wildfire effects were not always responsible for the loss of old growth characteristics. Delayed mortality due to fire, bark beetles, or other post-fire stressors was observed both in the low and mixed fire intensities and in stands where there were exams available from the year immediately following the wildfire. Taking a no-action approach to managing old growth, therefore, has its own risks.

With the exception of high intensity wildfire, stands that no longer meet Green et al (2005) old growth definitions, however, still retain some old growth structural characteristics. There are still large, old trees which are the central defining characteristic of old growth stands. Succession has not been set back to zero. Barring major disturbance, these stands will recover to meet Green et al (2005) old growth definitions in a relatively short time.

Treatment Impacts on Old Growth Associates

Northern Goshawk

This study showed that stands selected for old growth treatment on the Lolo National Forest typically occur in drier ponderosa pine/Douglas-fir stands that do not develop the vegetation components (i.e. higher basal area weighted diameter and canopy cover) typical of where goshawks nest on the Lolo (Appendix 9, Table 2). Goshawks were, however, detected in association with treated (4) and untreated areas (1) at frequencies similar to those found in a 2005 random survey of breeding goshawk presence in managed landscapes Region-wide (Kowalski 2005). Kowalski (2005) demonstrated, statistically, that goshawks are relatively common and widespread during the breeding season in managed landscapes Region-wide (Kowalski 2006). Results are also similar to McGrath et al. (2003) who found goshawks successfully nesting in similar habitats in the northwestern United States (n=82) closer to human disturbances compared with random sites. Results are also similar to Clough (2000) who in Region 1, found goshawks nesting in a heavily managed landscape where productivity levels were above or within the ranges reported in less managed landscapes throughout the western United States.

Because of the goshawk's long history of concern to the Forest Service and segments of the public, biologists on the Lolo National Forest (and Region-wide) have been protecting known-occupied nest stands from treatment-related disturbance in recent years. If a stand with recent or historic (10 years) nesting activity is documented in a proposed treatment area, biologists will drop the stand from any treatment altogether with added timing restrictions that do not allow ground disturbing activities anywhere near the nest during the nesting period to remove the potential for disturbance related effects (see Brewer *et al* 2007). Although the effects of human disturbance near nest sites are not well documented, Boal and Mannan (1994) and Squires and Kennedy (2006) for example surmised that human disturbance near nests (within 330 feet) can cause nest failure. Others have noted repeated nesting attempts by goshawks despite extreme disturbance (Zirrer 1947 *in* Squires and Kennedy 2006, Lolo National Forest unpubl. data on the Pattee Canyon goshawk). Nonetheless, the Forest provides protection measures to err on the conservative side.

One old growth treatment did occur in a stand with no documented pre-treatment occupancy, but with vegetation components consistent with where the species has been previously documented nesting (Appendix 9, Table 2, Line C) Post-treatment canopy cover and basal area measurements were lower than those reported for occupied sites in the northern Rockies. Although goshawks were not documented nesting in the stand during 2006 or 2007, results are inconclusive because pre-treatment occupancy data is not available for comparison.

In recent years, forests in Region 1, including the Lolo, have been following Reynolds et al. (1992) recommendations for providing adequate nesting habitat at the home range scale). Therefore, thinning an individual stand to restore and maintain old growth characteristics may occur, as Reynolds et al (1992) recommends. In Region 1, Moser (2007) found that timber harvest that occurred outside the breeding season, inside goshawk nesting areas had no short-term effects (1 to 2 years after treatment) on breeding area occupancy, nest success, or productivity as long as adequate nesting habitat is available. In habitats similar to those found on the Lolo, McGrath *et al* (2003) found that human disturbance does not appear to be a factor as long as 70% of the nest area structure is maintained and timber management operations are restricted to avoid activity during the breeding and fledging time periods. In recent years, the Lolo has begun protecting 100% of known occupied nest stands while leaving more than adequate nesting habitat at the home range scale.

To better understand stand level impacts of vegetation treatments on nesting goshawks, a more meaningful approach would be to experimentally design thinning treatments in stands actually occupied by nesting goshawks, with subsequent monitoring to determine the level of use post-treatment. However, this has never been done, nor is it possible, given current public concerns and direction that leads us to protect all occupied nesting habitat with no-treatment buffers.

Treatments in old growth on the Forest typically occur in stands that qualify as potential goshawk foraging habitat (Appendix 9, Table 2, Line C). All treatment types assessed by this study (including ecosystem burning, improvement cut, individual tree selection, and a combination of burning/thinning) resulted in canopy cover below the 40% presumed important by some researchers (summarized in Samson (2006a), displayed in Appendix 9, Table 2). Goshawks were detected in and near all four treatment types. However, goshawk foraging areas are large (1,400 to 8,650 acres) and contain a wide array of non-forested (0% canopy cover) and forested vegetation types of all tree size and canopy cover classes (i.e. summarized in Squires and Kennedy (2006)).

Goshawks are detected near (within about 984 feet) of the nest during a limited time period (5 days after young have hatched, the timing of which varies by weather or elevation, for a total period of about 40 days) (Kennedy and Stahlecker 1993, Joy *et al* 1994, Woodbridge and Hargis 2006 and demonstrated in Region 1 in Clough (2000)). As a result, we must monitor effects to foraging habitat at a broader scale by mapping vegetation around the nest site to quantify and characterize the arrangement of vegetation cover types in an "estimated" home range. The federal judiciary has directed the Forests to use Reynolds et al. (1992), who for goshawks, developed a habitat as a "proxy" approach to managing for goshawk nesting and foraging habitat at the home range scale.

Nesting goshawks occupancy and changes in nesting and foraging habitat are being monitored at the Region-wide population scale to obtain statistically reliable breeding population distribution and habitat information that cannot be collected at the stand or project scales. To date, the species and its habitat appear common, widely distributed and abundant Region-wide, with enough nesting and foraging habitat on the Lolo National Forest alone to support a viable population Region-wide (Kowalski 2006, Samson 2006a, 2006b, Brewer *et al* 2007, and Canfield 2007).

Goshawks are considered a generalist, opportunistic predator with large home ranges. Occupancy of these home ranges may vary annually, based on a number of non-habitat factors such as weather (see Appendix 4). As a result, scientific research on precise estimates of

habitat use by foraging goshawks during the nesting season is limited. A few studies report a narrow range of habitat conditions (i.e. forested canopy > 40%) (Beier and Drennan 1997; Finn *et al* 2002; Greenwald *et al* 2005, and summarized in Samson 2006a). A larger number of studies report a broad-range of habitat conditions (Reynolds *et al* 1992; Bright-Smith and Mannan 1994; Hargis *et al* 1994; Beier and Drannan 1997; and summarized in Squires and Kennedy 2006). For this reason, research scientists such as Reynolds *et al* (1992); Hargis *et al* (1994), USDI-FWS (1998), Graham *et al* (1999), and Squires and Kennedy (2006) emphasize maintaining a diversity of vegetation types and seral stages consistent with natural forest patterns. Reynolds *et al* (1992) and Graham *et al* (1999) have suggested that the use of controlled fire and thinning may improve habitat for goshawks by creating favorable conditions for goshawks and their prey (i.e., promoting diameter growth in overstory trees, creating open understories or downed wood).
Thinning dry forest types to restore old growth, as often proposed in Lolo National Forest projects, is consistent with this approach.

Flammulated Owl

On average, treatments in old growth on the Lolo often target flammulated owl habitat (10 of 16 stands sampled, Appendix 9, Table 3). Although, the species was detected in and near all treatment types, no pre-treatment occupancy data of the monitored stands was available for comparison. Continued monitoring, however, can give us insight into the continued use of managed areas by the owl.

Monitoring revealed that while thinning favors the larger diameter trees in the over-story, thus increasing the basal-area weighted diameter of the stands, canopy cover, on average, has been left slightly below the 35% minimum reported for owls in studies conducted in the northern Region, but maintained above the 20% where owls have been documented on the Lolo (Appendix 9, Table 3, summarized in Samson 2006a and discussed in Appendix 4).

Dry forest habitat at lower montane elevations in western Montana is common, widely distributed, and relatively continuous (Pfister *et al* 1977) providing many opportunities to manage habitat for flammulated owls. Small, patchily distributed stands of dry forest would have little value for restoration as flammulated owl habitat. It appears the species is well adapted to the historic stand components and structure that existed before logging and fire suppression (i.e. McCallum 1994, Wright 1996, Groves *et al* 1997, Linkhart 2001). Historically, frequent, low intensity fires within dry forest types created a landscape dominated by stands of large trees and maintained open, seral old growth (Losensky 1993, Habeck 1990, Arno 1997, Pfister *et al* 2000, Agee 2002, Hessberg *et al* 2005, Fiedler *et al* 2007, Kaufman *et al* 2007). Management geared toward the restoration of pre-European settlement habitat structure and stand distribution is an excellent prescription for flammulated owls based on our knowledge to date.

One caveat must be considered seriously concerning the use of logging and controlled burning to restore sites for wildlife: flammulated owls have indeed been found to occupy selectively-logged sites in the northern Rockies (Howey and Ritcey 1987, Wright 1996, USDA, Dawson Study 2006, Beaverhead-Deerlodge National Forest, unpubl. data, and this study)..

Prior to this study, the Lolo had been monitoring for owls since 1995 (upubl. data). In 2005, random sample of flammulated owl presence during the breeding season was conducted across all National Forests in Region 1. Results demonstrated that these owls are relatively common and widespread throughout managed (roaded) forests in Montana and northern Idaho, including the Lolo (Cilimburg 2005). No data shows that the species is in decline. Some researchers, i.e., McCallum (1994) have postulated that flammulated owls are "perhaps the most common raptor of the montane forests of the western United States", while others purport the opposite.

To gain knowledge on habitat availability, Samson (2006a, 2006b) estimated the amount of flammulated owl habitat by National Forest in Region 1 using FIA plot data. The data provide a statistically reliable sample wherein changes in habitat can be monitored over time. Coupled with the breeding distribution data displayed by Cilimburg (2005), flammulated owl and its habitat appear relatively common and widespread in managed habitats Region-wide, including the Lolo. Although a modest decline in ponderosa pine from 1942 to present was reported in 9 of 12 National Forests, Douglas-fir has increased in abundance more substantially, suggesting an overall increase in habitat for the owl (Samson 2006a). Flammulated owl habitat on the Lolo comprises 3 times the amount needed to maintain a minimum viable population Region-wide (*Ibid*.).

Since dry forest restoration could create significantly more habitat (or at least habitat that elicits a settling response) for flammulated owls than currently exists, demographic data (such as breeding area occupancy) to evaluate habitat quality is necessary. Wright et al. (1997) concluded that ongoing and future restoration activities in Montana will provide excellent research opportunities to assess habitat quality in logged and unlogged sites for the owl. As such, continued Region-wide population and habitat monitoring coupled with project-level monitoring pre- and post-treatment should continue as we move forward with restoring dry forest types.

To respond to information needs, the Region-wide inventory (discussed above) will be completed again in 2008 to monitor occupancy rates at the population level that cannot be done at the stand level and to obtain updated estimates of habitat selection by owls in managed forests of this region.

Pileated Woodpecker

In general, pileated woodpecker abundance appeared similar in both treated and untreated old growth stands on the Lolo.

In habitats similar to the Lolo in northeastern Oregon, Bull *et al* (1995) found that pileated woodpeckers continued to use stands treated by selection harvest, albeit at a lower level than untreated stands. A decade later, Bull *et al* (2005) found that fuels reduction treatments retained foraging habitat for the species. On Region 1 Forests including the Lolo, Hutto and Young (2002) found greater numbers of pileated woodpeckers (and a number of other bird species) in partially cut areas compared with uncut areas. They demonstrated that statistically reliable monitoring information collected at a Region-wide population level, rather than the individual stand level, can be used to effectively assess wildlife habitat relationships and the impact of forest management on a species.

In 2007, in cooperation with the Forest Service, the Avian Science Center (University of Montana) conducted a random sample of bird species abundance in old growth (including the Lolo) which found pileated woodpecker occurrence was common (unpubl. data).

Similar to the goshawk and flammulated owl (discussed above), Samson (2006a) obtained a statistically reliable estimate of pileated woodpecker habitat on each National Forest in Region 1 using FIA plot data so that changes in habitat can be monitored over time. Estimates of habitat clearly indicate that habitat for the species is abundant and well distributed Region-wide. On the Lolo, 98,463 acres of habitat is available for nesting and 157,981 acres for winter foraging (considered a critical time of year for the woodpecker). Available habitat on the Lolo alone is twice that needed to maintain a minimum viable population of the species in the entire region (Samson 2006b). Population monitoring data collected for breeding birds along random transects across Region 1, including the Lolo, from 1994 to 2000 show a clear upward trend in pileated woodpecker numbers, indicating viability is not a concern (http://www.birdsource.org/LBMP/).

Given the above, it is reasonable to infer that treatments to restore old growth conditions on the Lolo continue to provide old growth habitat for pileated woodpeckers.

Wildfire Impacts on Old Growth Associates

Scientific information on the direct effects of wildfire and fire suppression impacts on old-growth associates is limited. From monitoring we can say that pileated woodpeckers and flammulated owls were detected in or near burned stands, whereas goshawks were not. Only 8 stands with adequate vegetation data collected pre-fire could be monitored for species presence, and no pre-fire occupancy information is available for comparison. Monitoring did show that at the stand level, wildfire removed most of the live tree component necessary to support older forest associates, whereas treatment maintained most of the live components necessary to function as habitat.

All three old growth associates evolved under a diversity of fire regimes including mixed-severity and stand-replacing events. The large body of scientific literature on habitat associations for the species, indicate there appears to be a threshold of tree densities below and above defined levels which renders stands unusable (Appendix 4). For example, Linkhart (2001) concluded the association of flammulated owl productivity to open-grown forests with larger diameter trees suggests that the species is adapted to forests that were historically maintained by fire. Likewise, goshawk use of open-canopied forests for foraging and open understory conditions for nesting and foraging, suggest the species is also adapted to conditions that were historically maintained by fire (Appendix 4). Treatments intended to maintain or restore old growth, or reduce the potential for stand-replacement fire, are consistent with these species requirements.

MANAGEMENT RECOMMENDATIONS

Continued Region-wide population and habitat monitoring coupled with project-level monitoring pre- and post-treatment provides a reliable means of assessing the impacts of forest management as we cautiously move forward with restoring dry forest types, particularly for flammulated owl.

Treatments to restore old growth conditions on the Lolo continue to provide old growth habitat for old growth associates.

Researchers consistently note that objectives for managing habitat for old growth associates shown to use a wide array of non-forest and forest vegetation types to meet their life cycle, should be on maintaining a diversity of vegetation types and seral stages consistent with natural forest patterns. Thinning dry forest types to restore old growth is consistent with this approach.

Using the minimum old growth criteria in Green et al. alone as a means to quantify the amount of suitable habitat in an area would grossly underestimate what's available, given each species uses a much broader range of habitat conditions than those defined by Green et al.

However, beyond the minimum criteria in Green et al., the range of canopy covers recommended for each species should be considered in the design of management activities. Thinning and/or ecosystem maintenance burning objectives can easily be designed to provide for all three old growth associates.

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